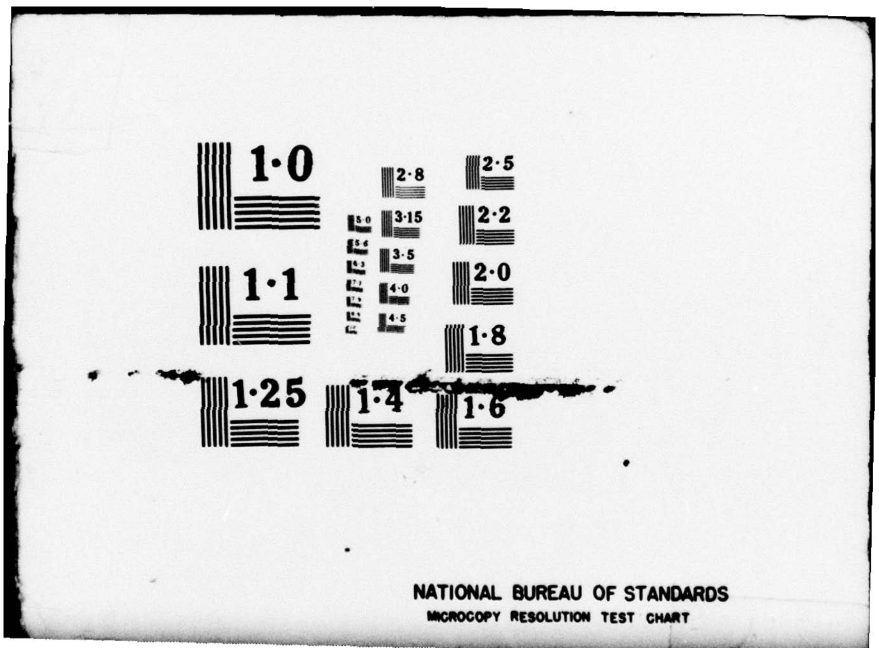
AD-A049 549 ARMY COMMUNICATIONS-ELECTRONICS ENGINEERING INSTALLAT--ETC F/G 9/5
ANTENNA SELECTION FOR IONOSPHERIC TELECOMMUNICATION SYSTEMS.(U)
JAN 77 G LANE

UNCLASSIFIED EMEO-PED-TM-77-1 NL

1 OF 1
ADA
049549

END
DATE
FILMED
6-78
DDC


1·0
1·1
1·25
1·4
1·6
1·8
2·0
2·2
2·5
2·8
3·15
3·5
4·0
4·5
NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER EMEO-PED-TM-77-1	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Antenna Selection For Ionospheric Telecommunication Systems		5. TYPE OF REPORT & PERIOD COVERED Technical Memorandum (Final) 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) George Lane		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS USACEEIA CCC-EMEO-PED Ft. Huachuca, Arizona 85613		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Propagation Engineering Program Area (AR 10-3)
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE January 77 13. NUMBER OF PAGES 5
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Ionosphere, Telecommunications, High Frequency, Antenna Selection

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This memorandum presents the general principles used in the design and analysis of ionospheric telecommunication sustems. In particular the requirements imposed by the propagating media are dicussed. A technique for data presentation of predicted circuit performance is given in addition to several nomographs which are useful to the antenna selection process.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

ANTENNA SELECTION FOR IONSOPHERIC TELECOMMUNICATION SYSTEMS

1. The HF propagation engineer is constantly faced with the problem of antenna selection for particular communication circuits. The choice is usually not an easy one since these variables must be considered in making the final selection:

a. Size (height and ground area)

b. Directivity (power gain, front-to-back ratio, area of coverage, take-off/arrival angles, etc.)

c. Siting (clearance, roughness factor, mutual coupling, scattering, safety, EMI, EMH, etc.)

d. Cost (price, maintainability, predicted performance vs communication requirement, etc.)

2. Generally, in ionospheric telecommunication system design, the propagation engineer needs only concern himself with selecting the electrical design parameters of the antenna which is predicted to meet the user's requirements for type and grade of service. The steps involved in making the selection may be as follows:

a. Determine the band of frequencies needed over the expected life time of the circuit.

b. Determine the expected range of take-off/arrival angles required to support the most probable ionospheric modes.

c. Establish the maximum path gain needed to meet the user's requirement for type and grade of service.

d. Select/design the antenna which meets the frequency, directivity and gain requirements described above.

3. A typical example of these three circuit requirements displayed in a convenient manner is shown in Figures 1 and 2 for an ionospheric telecommunications circuit between Ankara and Rawalpindi. The circuit analysis is made using the USACEEIA Skywave Prediction Program on the Fort Huachuca CDC 6500 computer. The analysis, as shown, was made using the assumptions of an available transmitter power of 2 KW pep and isotropic radiator and receptor for the antennas. The results of the analysis, which was made for March, June, September and December in a high (130) and low (10) sunspot number (SSN) years,

show that June and December, and March and September represent the extremes in the seasonal variation for this path for high and low SSN, respectively.

4. At this point the propagation engineer must be able to select an antenna to meet the requirements now depicted on the charts similar to the examples shown in Figures 1 and 2. Guidance given by the International Radio Consultative Committee* indicates that dipole types of antennas (i.e., single elements, yagi, log periodic arrays, etc.) are selected for paths generally less than 600 km or 393 miles. At greater ranges, long wire antennas tend to be more advantageous although low angle of fire arrays of dipoles or vertical elements may be superior at a greater cost. When one observes generalized angles of arrival as a function of range, one can see the logic in selecting the 600 km distance as the break point between high angle of fire antennas versus low angle of fire antennas. Such a chart is shown in Figure 3. Using this generalized data, the engineer can compute the optimum height of a horizontal dipole element in order to have optimal gain at the required take-off/arrival angle. A graph showing this information is given in Figure 4. Data shown in Figures 3 and 4 can be useful to the propagation engineer in the rapid selection of antennas to meet the needs of HF radio circuits of 600 km or less. For the intermediate and long range paths more careful consideration must be taken. Charts such as those shown in Figures 1 and 2 should be prepared. Long wire antenna designs need to be developed around the three path requirements of: frequency band, take-off/arrival angle, and path gain. These same variables can be used in selecting or specifying a commercial antenna design.

---

*Handbook of High-Frequency Directional Antennae. Published by the International Telecommunication Union, Geneva, 1966; pp. 52-60.

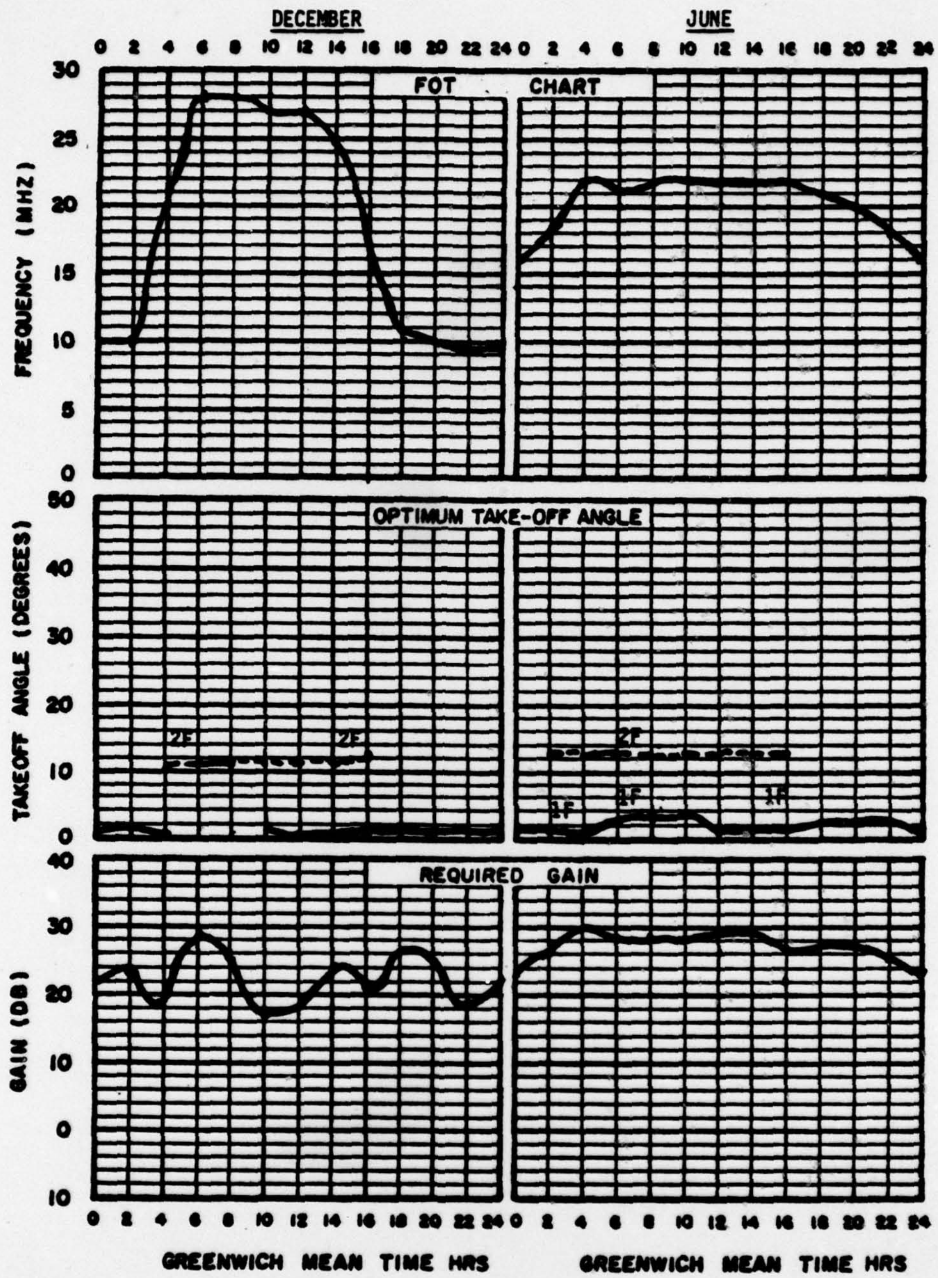


Figure 1 HF Analysis Summary for the Path Between Rawalpindi and Ankara, Isotropic Antennas and 2 KW (PEP) for a High Sunspot Year (SSN = 130).

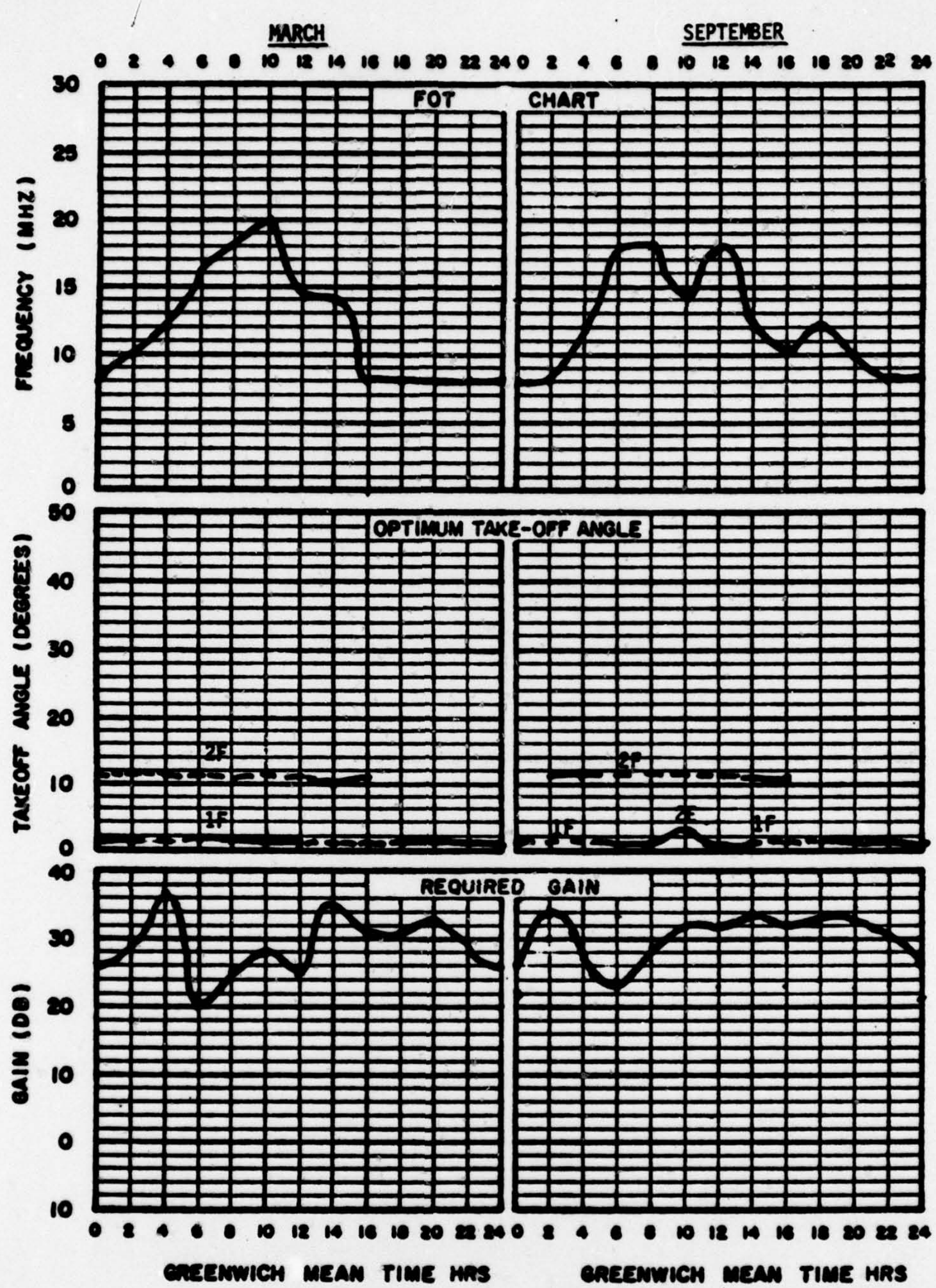


Figure 2 HF Path Analysis Summary for the Path Between Rawalpindi and Ankara, Isotropic Antennas and 2 KW (PEP) for a Low Sunspot Year (SSN = 10).

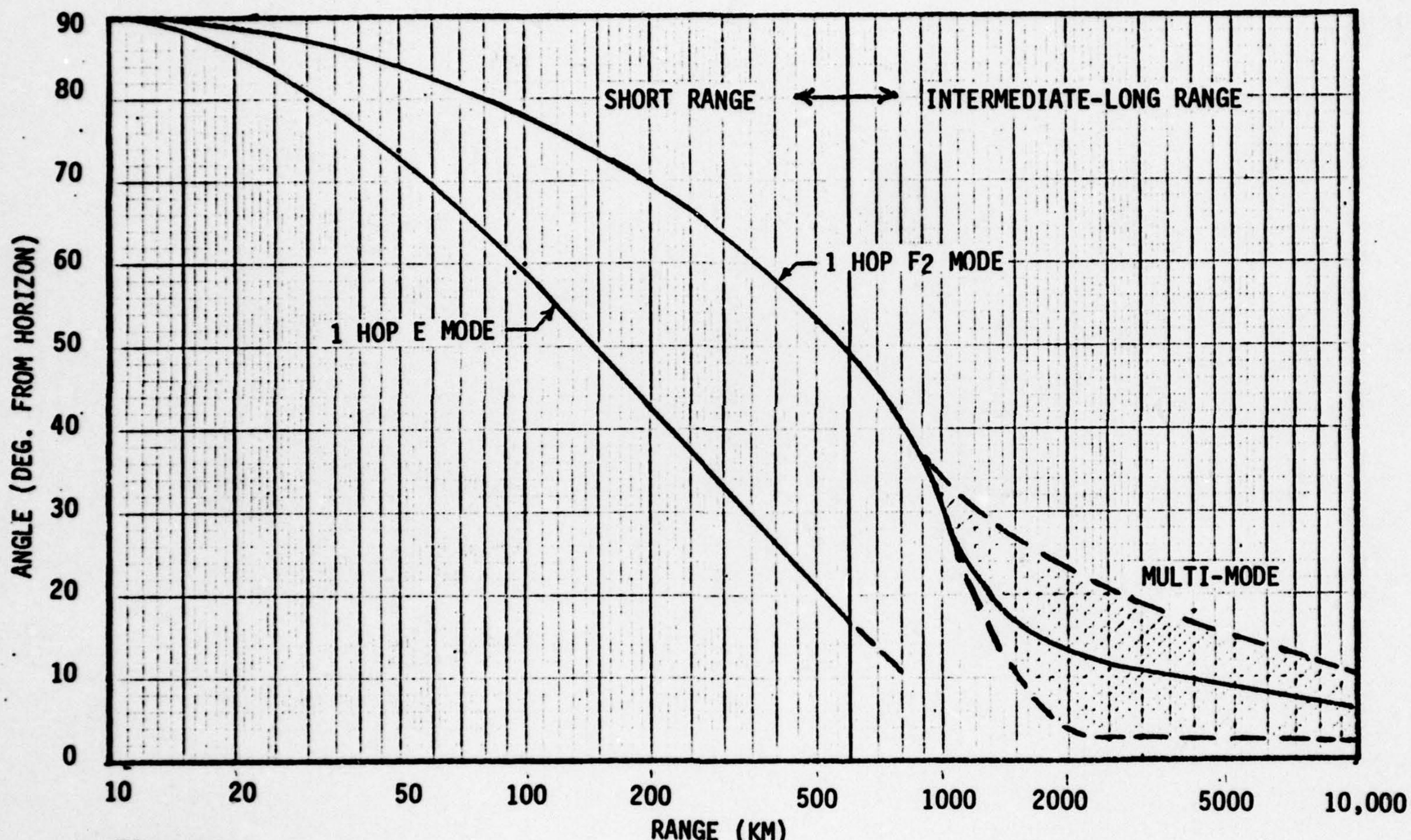
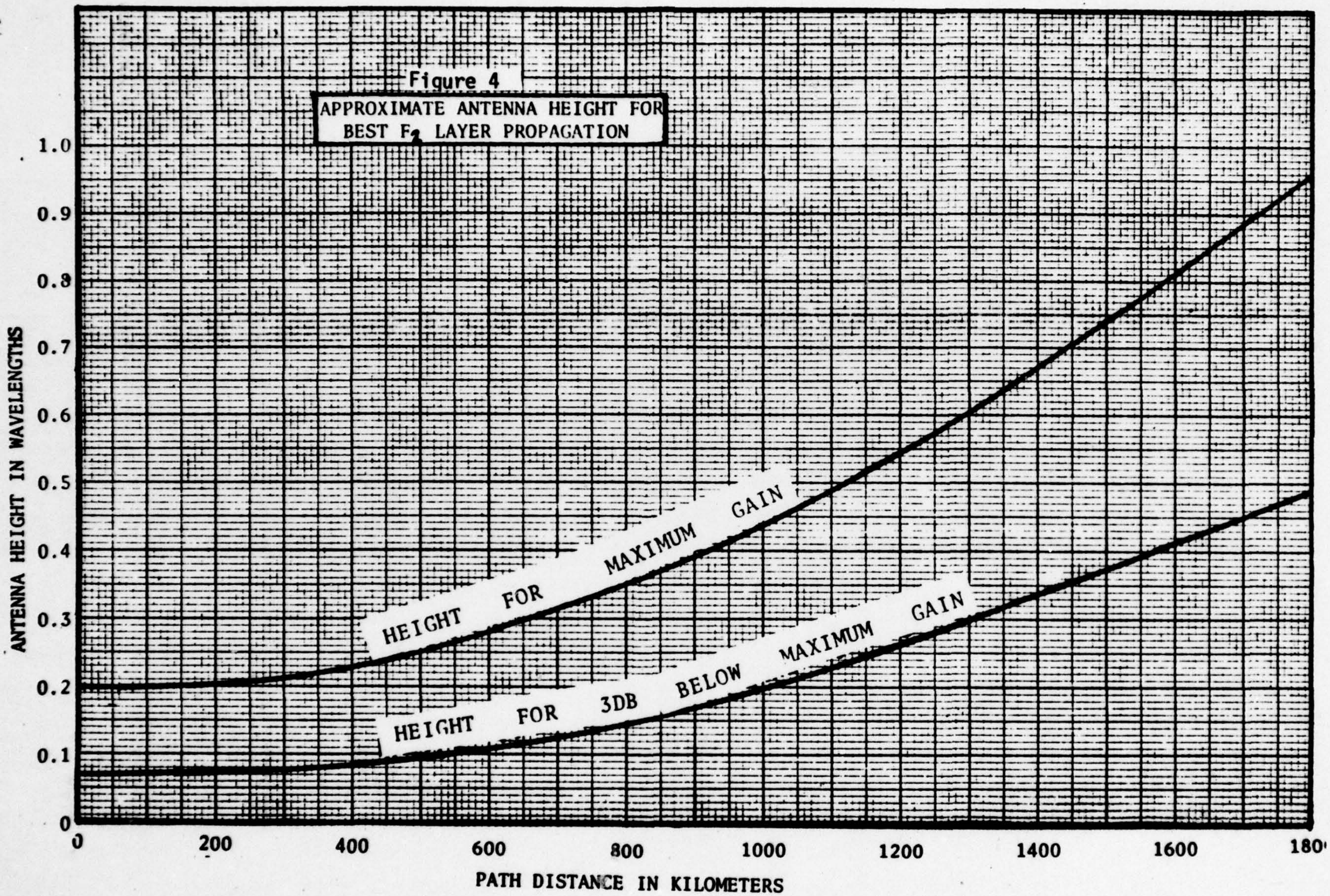


Figure 3
Take-Off/Arrival Angle for Ionospheric Transmissions as a Function of Range and Mode

Figure 4


APPROXIMATE ANTENNA HEIGHT FOR
BEST F_2 LAYER PROPAGATION
HEIGHT FOR MAXIMUM GAIN
HEIGHT FOR 3DB BELOW MAXIMUM GAIN
ANTENNA HEIGHT IN WAVELENGTHS
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0
200
400
600
800
1000
1200
1400
1600
180
PATH DISTANCE IN KILOMETERS